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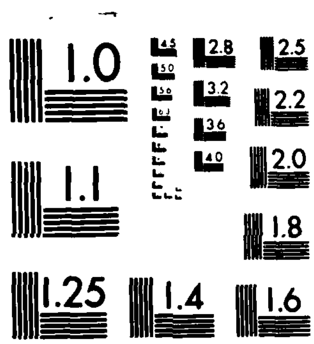

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THE 12TH INTERNATIONAL QUANTUM ELECTRONICS CONFERENCE

P.D. DRUMMOND
Univ. of Rochester, New York

31 MARCH 1983

UNITED STATES OF AMERICA

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The 12th International Quantum Electronics Conference was held in Munich, Germany, from 20 through 25 June 1982. This report describes presentations on dynamical nonlinearities, quantum optics, bistability, laser spectroscopy, and theory.

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THE 12TH INTERNATIONAL QUANTUM ELECTRONICS CONFERENCE

The 12th International Quantum Electronics Conference was held in Munich, Germany, from 20 through 25 June 1982. The meeting was one of the largest of its type, attracting scientists in many different areas of the theory, experimentation, and applications of laser technology. The European representation was larger than in previous years, as would be expected. A notable exception was the nearly complete absence of representatives from the strong research groups in Poland.

The meeting was organized and sponsored jointly by the European Physical Society, the Deutsche Physikalische Gesellschaft, the American Physical Society (through the joint Council on Quantum Electronics), the Optical Society of America, the IEEE-Quantum Electronics and Applications Society, the Max Planck Institut für Quantenoptik, the Deutsche Forschungsgemeinshaft, the European Research Office of the United States Army, and the Air Force Office of Scientific Research.

The conference was divided into 28 sessions (Table 1). Because of the concurrent sessions, it was impossible to attend and review all presentations; the published summaries of the papers occupy a complete issue of *Applied Physics* (Vol B28, No. 2/3 [1982], pp 81-310). Some of the sessions relevant to quantum optics are discussed here. This unavoidably omits a large part of the research, but an idea of the flavor and coverage of the papers is given; papers not mentioned were of equal or better quality and scientific interest.

Dynamical Nonlinearities and Bistability

A. Miller (Royal Signals and Radar Establishment, UK) and D.A.B. Miller, (Bell Laboratories, New Jersey) presented a paper on applications of semiconductors to infrared bistability. They emphasized that large differences can occur between atomic transition bistability and the band-band transition effects they are interested in.

M. Bensonsson and J.M. Moison (Centre National d'Etudes des Telecommunications, France) discussed multiquantum photoemission from a solid involving simultaneous absorption of up to eight photons, with both volume and surface effects occurring.

D.A.B. Miller, D.S. Chemla, P.W. Smith, A.C. Gossard, and W.T. Tsang (Bell Laboratories) reported the first observation of exciton saturation effects at room temperature in a multiple quantum well heterostructure. The observation required a new technology, namely the deposition of alternate layers of GaAs and GaAlAs, resulting in a superlattice in the direction orthogonal to the deposited planes.

J.V. Moloney, F.A. Hopf, and H.M. Gibbs (Optical Sciences Center, Arizona) reported on a theoretical model of optical bistability using a two-dimensional ring interferometer with time-delayed periodic boundaries. The results showed a qualitative resemblance to observations in a three-dimensional Fabry-Perot etalon. At large intensities and detunings, with short relaxation times, chaotic behavior was found in the numerical simulations.

D.F. Walls (Univ. of Waikato, New Zealand) presented a paper that showed the existence of many phase-transitions and instabilities that had not been observed

Table 1
Conference Sessions

1. Nonlinear Spectroscopy
2. Dynamical Nonlinearities and Optical Bistability
3. Quantum Optics
4. Laser Chemical Physics I: State Selective Excitation
5. New Lasers
6. Bistability
7. Nonlinear Optical Processes I
8. Free Electron Laser
9. Phase Conjugation
10. Theory I
11. Picosecond Pulses and Applications
12. Laser Chemical Physics II: Infrared Multiple Photon Dissociation
13. Laser Spectroscopy
14. New Lasers, VUV Sources
15. Semiconductor Laser Physics
16. Laser Chemical Physics III
17. Surface Spectroscopy
18. New Lasers II
19. Laser-Biophysics
20. Applications of Picosecond Pulses
21. Theory II
22. Nonlinear Processes II
23. Laser Fusion
24. Coherent Transient Phenomena
25. Guided Waves and Infrared Lasers
26. Laser Plasmas
27. Novel Spectroscopy
28. F-Center Lasers, Superconductivity

before. They chiefly involved multiple mode inputs rather than the single-mode, single-frequency inputs investigated by the earlier speakers.

The general trend of the session was toward Kerr-effect (dispersive) nonlinearities in solid-state dielectrics. However, the last paper, by Walls, showed that many nonlinearities other than the Kerr effect could be used to create bistability.

Quantum Optics

M.J. Konopnicki, P.D. Drummond, and J.H. Eberly (Univ. of Rochester, New York) presented results on the simultaneous lossless propagation in nonlinear absorbers of laser radiation with more than one frequency or polarization. The possible applications to optical switching were treated.

S. Ezekiel (Massachusetts Institute of Technology [MIT]) gave a fascinating talk on fiber-optic rotation sensors. While emphasizing the practical difficulties, he held out hope of testing general relativity theory using such devices.

A.E. Kaplan (MIT) and P. Meystre (Max Planck Institut für Quantenoptic, FRG) discussed recent advances in the theory of fiber-optic rotation sensors. The authors claimed that large improvements in sensitivity would occur by using the nonlinear Sagnac effect.

F.T. Hioe and J.H. Eberly (Univ. of Rochester) reported on their recent development of the theory of invariances in the density matrix of an N-level quantum system interacting losslessly with arbitrary laser inputs.

Walls and G.J. Milburn (Univ. of Waikato) discussed the theoretical implications of the "squeezed" state. This is a form of laser-induced radiation in which the fluctuations in one quadrature are

reduced at the expense of fluctuations in another, with possible applications in interferometers.

G. Strini, F. Casagrande, and L.A. Lugiato (Istituto di Scienze Fisiche dell' Univ. Milano, Italy) reported on the theory of squeezed state production in a possible device--the two-photon laser. They found, however, that there would be no squeezing in such a case, although it would occur in some related passive devices. In a related paper, H.P. Yuen (Northwestern Univ., Illinois) pointed out that the existence of the squeezing depended on the model chosen for the two-photon laser. He showed a calculation that did result in such an effect if the fluctuations of the pumping process were omitted.

An interesting point in the session was the theoretical work by the Italian group. The research showed that phase fluctuations induced by the optical pumping that powers the laser would prevent squeezed photon statistics in a working two-photon laser--if a fixed phase-reference were used to define the squeezing.

Bistability

W.J. Firth, C.T. Seaton, E.M. Wright, and S.D. Smith (Heriot-Watt Univ., UK) reported on experiments on bistability in InSb at 77°K, showing the existence of changes in the transverse mode structure with Gaussian beam inputs to a plane-parallel dispersive etalon.

Smith, Seaton, and M.E. Prise (Heriot-Watt Univ.) reported on the fast "switching-up" of a bistable etalon when a 30-ps-long switching input is used. Switching down, requiring the decay of excess carrier density, was reported to be much slower, which could be expected from theoretical predictions.

J. Mlyneck, F. Mitschke, R. Deseno, and W. Lange (Univ. of Hannover, FRG) reported on an experiment in bistability that used a theoretically expected, although previously unobserved phenomenon: the bistability due to three-level optical pumping in a magnetic field, using Zeeman sublevels.

P.W. Smith and W.J. Tomlinson (Bell Laboratories) reported on their numerical predictions of switching at a nonlinear dielectric interface. The two-dimensional calculations were compared with an experiment using Gaussian input beams. Some differences between theory and experiment were noticed.

Ch. Harder, K.Y. Lau, and A. Yariv (California Institute of Technology) reported on experiments using a laser with a saturable absorber, showing bistability. While the effect has been observed before, the authors presented results on an interesting new way of doing the experiment; a GaAs laser with heterogeneous gain was used.

J.C. Khoo, S. Shephard, S. Nahar, and S.L. Zhuang, (Wayne State Univ., Michigan) rounded out the session with their paper on quite a different type of bistability; it requires a liquid crystal medium. The process was slower than others reported in the session, and it might have applications in the memory of storage devices.

Despite the obvious advances in device technology, the experiments described generally lacked comparisons with theory. In most cases, no quantitative theory was presented, indicating that the theorists are lagging somewhat in this rapidly changing physical research field.

Laser Spectroscopy

While the laser spectroscopy session primarily dealt with colli-

sional effects in spectroscopy, one paper was highly relevant to quantum optics. It was a report by G.L. Burdge and Chi H. Lee (Univ. of Maryland) on sideband emission from radiation propagating through sodium vapor. The authors found off-axial components that were red-shifted from resonance but not so greatly red-shifted as the Rabi sidebands. This could not be explained using previous theoretical models.

The sideband emission is an interesting and quantitatively unsolved quantum optical problem. The new observations appeared to require additional theoretical work.

Theory II

M. Lu and M. Sargent III (Optical Sciences Center, Arizona) presented a paper on phase conjugation in a medium with a two-photon transition. The theory included the effects of detuning on the response.

P.E. Coleman and P.L. Knight (Imperial College, UK) studied a model of pseudo-autoionization that involved two levels coupled by input fields to ionizing levels. New interference effects between the ionizing channels were predicted.

G.P. Agrawal (City College, New York) presented results of a theoretical study of four-wave mixing phase conjugation, including bichromatic counterpropagating pumps. Reflectivities were predicted with relatively high efficiency because of the elimination of spatial hole-burning.

P.D. Drummond (Univ. of Rochester) and F.P. Mattar (Polytechnic Institute of New York) presented a paper on modeling propagation in nonlinear media; recent advances in computer modeling were reported.

S.P. Hildred and R.K. Bullough (Univ. of Manchester, UK), and S.S. Hassan (Ains Shams Univ., Egypt) discussed results of an analysis of resonance fluorescence with a mixed coherent-chaotic field. Both one-atom and more-than-one-atom results were presented.

The theoretical papers in the session showed that researchers were investigating an extremely wide range of problems. Progress in phase-conjugation, auto-ionization, laser propagation, superfluorescence, and laser fluctuations indicated scientific developments as well as possible applications.

In summary, the meeting was reasonably successful, with a variety of interests represented; the sessions reflected the diversity of laser-related fields. Of course, this caused difficulties in the interactions between researchers in different areas. In fact, some researchers complained about the organizational difficulties inherent in a meeting of such size. Overall, one might hope that the future Quantum Electronics Conferences will be smaller (to help participants communicate with each other), while preserving a representation of both theorists and experimentalists.

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